Circular economy and design for change within the built environment: preparing the transition

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Abstract

The built environment is considered as a key sector in which circular economy can be implemented. Within the H2020 project "Building as Material Banks" (BAMB), two innovative solutions are being forward to support this transition: i.e. Materials Passports and Reversible Building Design Protocols.
Based on desk research and interviews with frontrunners, key opportunities and barriers have been identified related to the implementation of both innovative solutions within policy, commercial, societal and R&D realms. In order to better understand these opportunities and barriers five emerging trends putting the current socio-technical system under pressure are explained. In addition, value chain and value network analyses of business-as-usual and state-of-the-art practices have been examined over major building phases: conceptualisation & design, construction, usage/operation, demolition/deconstruction & repurposing. We observed that that it is unlikely that an actor will be involved within all phases of the building and that the availability of building (product) information over all building phases is restricted. By supporting the development of Materials Passports and Reversible Building Design Protocols actors involves within the conceptualisation, design and construction stages will better understand why circular and change-supporting building design strategies are necessary. Moreover, the development of Materials Passport IT Platform and a BIM prototype will serve as a proof-of-concept on exchanging information on building products and the building's operation to actors involved within reverse logistics.

Keywords: system analysis, value network, actor analysis, building.

Introduction

According to SytemiQ & Ellen MacArthur Foundation [1], three circular innovation priorities within the built environment have been identified: i.e. designing and producing multi-usage, modular/transformable, energy-positive buildings from durable, non-toxic materials; boosting re-use of building materials and components, and integrating circular economy principles into urban design and development.
The Building as Material Banks (BAMB) project [2] introduces two innovative solutions to support these priorities: Materials Passports – i.e. digital sets of data describing defined characteristics of materials and components in products and systems that give them value for present use, recovery and reuse – and Reversible Building Design Protocols – i.e. instruments to inform designers and decision makers about the technical and spatial reversibility of building design(s) and the impacts of design solutions during the conceptual design phase.

This paper seeks answers to the following question: how can Materials Passports and Reversible Building Design Protocols support the transition towards integration of circular economy and related design strategies within the built environment?

Methodology

In order to answer the research question, three iterative actions have been undertaken: (1) analysing the current system (in which currently buildings are designed, constructed, renovated and demolished), (2) identifying the required system changes (towards an integration of circular economy within the built environment) and (3) describing the key opportunities and barriers related to Materials Passports and Reversible Building Design Protocols to be used and applied within building practice.
The above actions were the result of co-creation between all partners within the BAMB project, through interactive face-to-face and group sessions, value network analyses, state-of-the-art reporting, monitoring of niche activities and back-casting of leverage actions – starting from a desired view of the future. More information on the above activities is elaborated by Debacker et al. [3].

Results

Analysing the current system. From a process point of view, the value chain of a building is described according to 4 main phases: (1) conceptualisation & design, (2) construction, (3) usage & operation and (4) repurposing & demolition/deconstruction. These phases can be further subdivided in smaller stages and milestones. From a stakeholder perspective, the built environment is the playing field of a broad variety of actors, from different type of users and owners to building professionals and policy actors. Based on a thorough analysis of the value network and the value chain of different building types and building practices within several EU countries, we observed that it is very unlikely that an actor will be involved in all building phases. Most actors are only involved in one or two main phases; and not throughout the entire value chain. We observed that the design and construction phases have relatively well established connections in terms of actors that are involved in both. However, as soon as the building is commissioned, these connections are cut off and actors that were involved in the design and construction of the building are rarely involved again during later phases. This means that a lot of valuable information about the construction, the operation, the materials and the reuse/recycling/recovery options is not available for the actors involved within repurposing and demolition/deconstruction activities. Seen from the demolition/deconstruction side, this also means that building design and construction actors do seldom take into account the end-of-use consequences when making design or construction choices, leading to waste streams that cannot be recycled or only down-cycled. Moreover, if potential end-of-use issues would be taken into account during the design and construction phases, this would also facilitate the reuse of components, that are often worth much more than their constituent materials.
Making changes in the value network is all but easy in a dominantly conservative building sector, with practises based on decades and centuries of traditions. Current renewal and refurbishment of buildings usually end up into linear solutions, because (innovative) circular and reversible building solutions are perceived as too expensive compared to the conventional solutions, being optimised for decades. However, this is viewed from a short-term perspective (i.e. taking into account only the initial investment cost and not potential life cycle gains) and based on traditional business and financing models, in which ownership of products is being pushed forward instead of (performance based) product service systems, in

which resources/products are taken back by the same manufacturer or pooled with others. Furthermore, based on the completed state-of-the-art analyses, 5 main landscape trends have been discerned: (1) increasing awareness of sustainability and circular economy; (2) down-cycling and disposal of construction and demolition waste as mainstream waste management solutions within EU; (3) building vacancy and premature demolition due to mono-functional design; (4) a third digitalisation wave towards cognitive buildings and (5) an increasing number of fragmented building regulation and building codes, making manufacturing, architectural and engineering industries reluctant to take on (additional) responsibilities.

Required systemic changes. To support the transition towards a change-supporting and circular built environment, some systemic shifts are required: i.e.

1. **Change in design culture:** (a) design buildings to support future change and possible disassembly, instead of (merely) designing them to be constructed and create the illusion they will last forever; (b) design open building systems – with the intention to exchange building components – instead of designing buildings as such; (c) educate building and product designer through life-long learning in designing for the future
2. **Intense collaboration within the entire value network:** (a) involve key stakeholders in all important decision moments; from conceptualisation, design, to repurposing of buildings and building components; (b) Initiate harmonisation agreements within the building industry, in order to coordinate dimensions of building components and standardise connection systems. (c) provide quality reassurance of reclaimed products and recycled materials, by matching (reverse) supply with demand
3. **Business creation through product service** systems: (a) develop business models leading to a win-win situation for end-users and manufacturers – providing end-users access to affordable and high quality buildings **and** manufacturers valuable resources; (b) **c**reate business opportunities based on user-ship instead of owner-ship, through performance-based product services
4. **Centralised management of building and material information**: (a) **s**tore building information related to current, past and potential future situations in a digital and centralised way; (b) **c**reate trust within the value network, by providing transparent and traceable information; (c) use digitalised information to learn and/or augmented intelligence

Innovative solutions. Although the identified systemic changes will not happen in one-day, it is of crucial importance to start the transition today. Within the BAMB project, the development of Materials Passports and Reversible Building Design Protocols are considered as first step to support the transition. Key opportunities and barriers have been defined, should both instruments be fully implemented within building practice and policy. Main opportunities are: (1) anticipating demographic changes and changing user requirements, (2) eradicating C&D waste, (3) lowering environmental and health pressures of the built environment. (4) development of applied socio-technical solutions, (5) development of guidelines and assessment instruments, (6) exchanging valuable (resource) information within the value network; (7) introduction of new commercial services on the market; (8) introduction of innovative business models; (9) increasing adaptability and versatile use of space; (10) increasing life expectancy and real value of real estate; (11) decreasing renovation costs and added value of reusable building components; (12) decreasing periodic maintenance and replacement costs.

Main barriers are: (1) fragmented policy framework: from the EU to municipalities, (2) conflicting Energy and. Environment policy measures; (3) lack of standardisation of qualitative data/ information over the entire value chain of the product/building; (4) intellectual property of material and product related data, (5) linear construction industry

models; (6) higher complexity of disassembly compared to demolition; (7) general perception that reversible design solutions entail high financial costs; (8) lack of certification and quality assurance for reclaimed products and recycled materials; (9) lack of a business model framework related to circular and reversible building; (10) Reversible building is largely unknown to the general public.

Conclusion

In order to foster circularity in the building sector, connections between all phases in the value chain are necessary in order to support communication and information transfer across the whole of the value network. This is exactly what the BAMB project is aiming for! By supporting the development of Reversible Building Design Protocols, Materials Passports and related decision-making instruments during this innovation action project, actors involved in the conceptualisation & design and construction will have a better understanding on the potential consequences of their decisions made during these two crucial phases within the value chain. Moreover, the development of a Materials Passport IT Platform and a BIM prototype will serve as a proof-of-concept on exchanging information on building products and the building's operation to actors involved in the reverse logistics.

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